$$\therefore \frac{d^2x}{dt^2}\left(\frac{b^2+k^2}{b^2}\right)+\frac{gx}{R}=0. \quad \therefore \frac{dx^2}{dt^2}+\frac{5gx}{7R}=0.$$

$$\left(\frac{dx}{dt}\right)^2=\frac{5g}{7R}(a^2-x)^2 \text{ or } T=\frac{\pi}{2}\sqrt{\frac{7R}{5g}}.$$

Let $R=20902410$ feet, $g=32.10614$ feet. Then $\sqrt{(R/g)}=806.871$.
$t=1267.433$ seconds $=21$ minutes, 7.433 seconds.
$T=1499.627$ seconds $=24$ minutes, 59.627 seconds.

t, T the time for the sphere to move from rest at the surface to the middle of the tunnel is constant for tunnels of all lengths and the same as for a tunnel passing through the center of the earth.

228. Proposed by J. E. ROSE, Mount Angel College, Mount Angel, Oregon.

AB, BC are two uniform rods freely hinged at B, whose weights are W, $4W$, and lengths $2a$, $4a$, respectively. The ends A, C of the rods are attached to small rings which slide on a rough horizontal wire. When the distance between the rings is the greatest for which equilibrium can exist, both of them are on the point of slipping. Find the coefficient of friction.

Solution by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa., and S. LEFSEHETZ, Pittsburg, Pa.

Let R, R' be the reactions at C, A, respectively; μR, $\nu R'$ the friction at these points; $\angle BAC=\theta$, $\angle BCA=\phi$.

Then $R+R'=5W$, $\mu R=\nu R'$...(1, 2).

Taking moments around B we get

$2R'\cos\theta=2\nu R'\sin\theta+W\cos\theta$ or $R'=W/[2(1-\nu\tan\theta)]$...(3).
$2R\cos\phi=2\mu R\sin\phi+4W\cos\phi$ or $R=2W/(1-\mu\tan\phi)$...(4).

(1, 2) in (3) and (4) gives $9\mu-\nu=10\mu\nu\tan\theta$, $3\nu-2\mu=5\mu\nu\tan\phi$.

$$\therefore \frac{5}{\tan\phi+6\tan\phi}=\nu, \ \frac{5}{4\tan\theta+9\tan\phi}=\mu.$$

In this problem, $\mu=\nu$. $\therefore \mu=\frac{4}{5}\cot\theta=\frac{1}{5}\cot\phi$. $\therefore \tan\theta=4\tan\phi$.
Also $\sin\theta : \sin\phi=2:1$, or $\sin\theta=2\sin\phi$.
$\therefore \tan\phi=\frac{1}{2}$. $\therefore \mu=\frac{2}{5}$.